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Abstract

AEROSPACE SAFETY OF ISOTOPIC AND REACTOR POWER SOURCES

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This paper describes the aerospace nuclear safety program being carried out for the United States Atomic Energy Commission by the Sandia Corporation. The program calls for an independent assessment of the safety aspects of the application of nuclear power supplies to aerospace vehicles. The safety program includes analytical modeling, research investigations, ground tests, and reentry flight tests, all designed to reduce areas of quantitative uncertainty which may emerge during the review of the safety plan for a specific system.

One area of investigation which is of concern to most aerospace nuclear power supply applications is that of reentry heating and burn-up phenomena. The problem of survival of reentry heating, both on the relatively steep reentry trajectories of the ICBM and the shallower reentry of the manned orbital flights, has received considerable attention over the past few years. On the other hand, the deliberate use of the mechanisms of orbital reentry heating for the burn-up and dispersal of various materials in various configurations has been of limited interest, except to the designers of aerospace nuclear power supplies. The effort undertaken by Sandia Corporation during the past two years has included the investigation of experimental and analytical techniques for predicting reentry heating and burn-up. These investigations have emphasized the need for improved simulation facilities and for additional material properties studies. Under reentry conditions at elevated temperatures, the properties of the materials used in the power supply appear to be one of the major sources of uncertainty in many of the analyses. Steps are being taken to fill in the gaps in knowledge of such properties for materials used in aerospace nuclear power supply systems. An outline of the materials properties investigation program is presented.

Once burn-up or ablation conditions are reached during reentry heating, the nature of droplet formation and final particle size distribution become of interest for the particular materials under study. Progress of investigations

into the mechanisms of ablation droplet formation is discussed. The current state of knowledge regarding the prediction of the transport, dispersion and deposition of particles introduced into the upper atmosphere by reentry burn-up is described.

Assessment of the safety of the aerospace nuclear power supply under all conditions of handling and transport from fabrication through suborbital flight calls for various ground testing capabilities to simulate the conditions to which the power supply might be subjected. The impact shock conditions into various media have been simulated effectively by various rocket sled techniques. The limited quantitative knowledge regarding overpressure levels and temperature-time histories caused by launch pad explosions and fires has led to a program for the instrumentation of several launch sites to collect this kind of information so that more accurate simulation in ground tests can be achieved.

In order to verify the disassembly features incorporated into a particular aerospace nuclear system by the designer, as well as to ascertain current capability for predicting reentry heating, a flight test was conducted in May of 1963 utilizing a NASA Scout vehicle to place a Sandia payload into a shallow reentry flight on the Wallops Island range. Good telemetered data was received until ionization blackout occurred, and optical data was obtained from ground cameras and aircraft. A summary of this flight test and results are given, and also a brief description of a second reentry flight planned for 1964.